

A new species of the genus *Neopetrolisthes* Miyake, 1937 (Crustacea: Decapoda: Porcellanidae) from the Ryukyu Islands, southwestern Japan

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Abstract.—A new porcellanid crab, *Neopetrolisthes spinatus*, is described and illustrated based on the specimens collected from Okinawa Island of the Ryukyus, southwestern Japan. This species is well characterized and distinguished from the other species of *Neopetrolisthes* Miyake by having an uneven dorsal surface of the carapace and supraocular spines. *Neopetrolisthes spinatus* occurs as a male/female pair on a sea anemone, *Heteractis malu* (Haddon & Shackleton). Although most of the morphological characters considered to distinguish *Neopetrolisthes* from *Petrolisthes* Stimpson are found in some or many species of the latter genus, *Neopetrolisthes* differs from *Petrolisthes* by having the gastric region of the carapace strongly elevated.

The genus *Neopetrolisthes* Miyake, 1937 contains two or three Indo-West Pacific species and they are usually associated symbiotically with large sea anemones of the genus *Stichodactyla* Brandt (this genus has been treated as *Stoichactis* Haddon) (see Miyake 1942, Haig 1979, Debelius 1984). These porcellanid crabs are well known as one of the common crustaceans in subtropical and tropical shallow waters because of their beautiful spots of red, brown or blue color on the carapace and pereopods.

Haig (1965, 1979) considered *N. ohshimai* Miyake, 1937 as a junior synonym of *Porcellana maculata* H. Milne Edwards, 1837 (= *N. maculatus*), and pointed out that the Indian and Pacific Ocean populations of *N. maculatus* have different spot patterns. In the former population, the carapace and pereopods are covered with small, rounded, evenly distributed spots; whereas in the latter population, the color pattern takes the form of large, uneven blotches. However, Debelius (1984) expressed the opinion that the spot pattern was a specific character,

and that the Indian Ocean population was applicable to *N. maculatus* and the Pacific Ocean population to *N. ohshimai*. As shown in the color illustrations provided by Kamezaki et al. (1988), we also found that both spotted crabs co-existed in the Ryukyu Islands, but could not distinguish them using morphological structures. To confirm the correct taxonomic status of the anemone crabs having different spot patterns, detailed morphological observations combined with ecological or molecular/genetic data of specimens from various Indo-Pacific localities are needed. Until such observations are made, we prefer to treat them under the name *N. maculatus*, and consider that this species has various spot sizes of red, reddish purple, or brown color on the carapace and pereopods.

The remaining known species of *Neopetrolisthes*, *N. alobatus* (Laurie, 1926), has been recorded only from the Cargados Carajós Islands (the type locality) and Mozambique, located in the eastern African coast (Laurie 1926, Kensley 1970, as *Pe-*

trolisthes alobatus). *Neopetrolisthes alobatus* is easily distinguished from *N. maculatus* by numerous strong, transverse striae and large blue spots on the dorsal surface of the carapace, and lack of distinct teeth on the dorsoflexor margin of the carpus of the chelipeds (Haig 1966, Kensley 1970 as *Petrolisthes alobatus*, Debelius 1984).

The second author recently collected unusual porcellanid crabs associated symbiotically with the sea anemone *Heteractis malu* (Haddon & Shackleton) (fide Gosliner et al. 1996), from Okinawa Island of the Ryukyus. Examination of these crabs revealed that they belong to the genus *Neopetrolisthes*, but are distinguished from all known species of this genus by having an uneven dorsal surface of the carapace and supraocular spines. Herein, we describe and illustrate them as a new species.

Measurements of carapace length (CL), chelipeds, and ambulatory legs follow those of Osawa (1998b). The type specimens are deposited in the National Science Museum, Tokyo, Japan (NSMT).

Neopetrolisthes spinatus, new species

Figs. 1–4

Neopetrolisthes maculatus.—Masuda, 1999:58, unnumbered figure. [Not *Neopetrolisthes maculatus* (H. Milne Edwards, 1837)]

Type material.—Holotype: male (CL 8.6 mm), Zanpa Promontory, Okinawa Island, associated with *Heteractis malu*, 5.0 m, 30 Oct 1998, coll. Y. Fujita, NSMT-Cr 13062. Paratypes: 1 female (CL 10.6 mm), data as in holotype, occurred with holotype as male/female pair on same host, NSMT-Cr 13063; 1 male (CL 6.0 mm), 1 female (CL 9.5 mm); Zanpa Promontory, Okinawa Island, associated with *Heteractis malu*, occurred as male/female pair on same host, 19.7 m, 12 Jun 1999, coll. Y. Fujita, NSMT-Cr 13064.

Description.—Carapace (Fig. 1A–C) 1.1 (paratype female, NSMT-Cr 13063)–1.3 (holotype male) times as long as broad,

usually broadest at anterior to median branchial regions (median region in holotype). Dorsal surface moderately convex in general appearance, covered with short transverse rugae; those of median branchial regions being longer and stronger than other regions, those of hepatic regions weaker and fewer in number. Rostrum (Fig. 1D) broad, slightly bent ventrally; frontal margin sinuously triangular; median lobe strongly produced forward, with narrowly rounded apex; lateral lobes with oblique anterior margin. Orbits moderately concave; supraorbital margins strongly oblique, with distinct spine on slightly elevated ridge; outer orbital angles strongly produced but unarmed. Protogastric ridge well developed, divided into 2 lobes by median groove extending to tip of rostrum; lobes directed anteriorly, with strong spine-like appearance in lateral view. Gastric region strongly elevated. Cervical grooves deep. Acute epibranchial spines present. Branchial margins with longitudinal edges bearing strong elevation on anterior to median region; anterior margins moderately to strongly convex; median margins subparallel. Branchial regions with broad, well elevated part situated slightly behind of marginal elevation; anterior branchial regions slightly depressed, with small, flattish, rounded squamae.

Pterygostomian flaps (Fig. 1C) entire, unarmed, moderately narrowing posteriorly, with longitudinal, long rugae.

Third thoracic sternite (Fig. 1E, F) strongly depressed, incompletely divided from fourth sternite by large, median interruption, trilobate anteriorly; median lobe distinctly exceeding laterals, with moderately (male) or very broadly (female) rounded apex; lateral lobes narrow. Fourth sternite with series of short rugae along concave anterior margin; rugae of male stronger than those of female; setae on anterior sides of rugae of female longer and much more in number than those of male.

Telson (Fig. 1G) as illustrated, consisting of 7 plates with short distal plates.

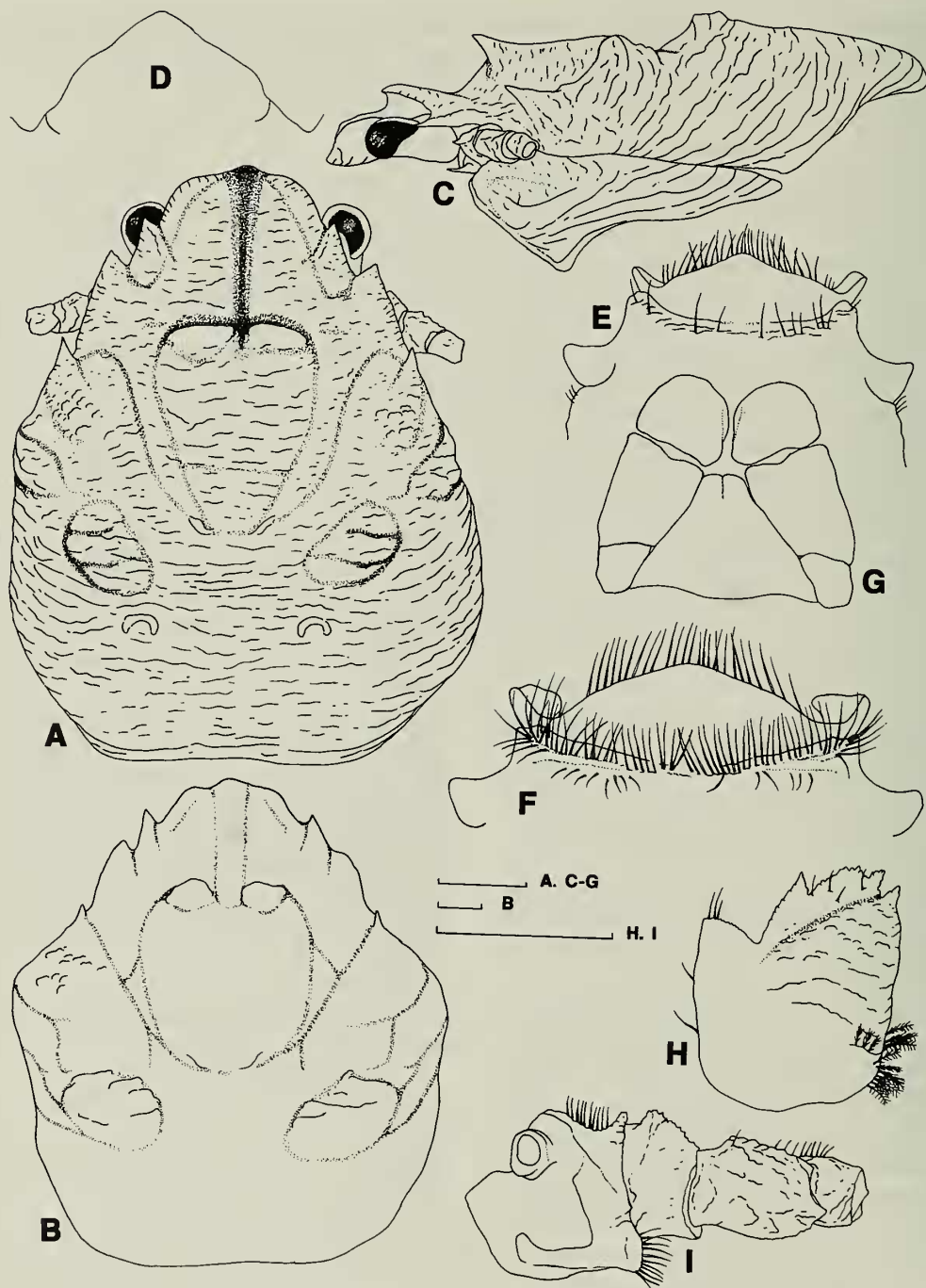


Fig. 1. *Neopetrolisthes spinatus*, new species. A, C-E, G-I, holotype, male (NSMT-Cr 13062, CL 8.6 mm); B, F, paratype, female (NSMT-Cr 13063, CL 10.6 mm). A, B, carapace, dorsal; C, carapace and pterygostomian flap, lateral; D, rostrum, dorsofrontal; E, F, anterior thoracic sternites, ventral; G, telson, extensor; H, left basal segment of antennular peduncle, ventral; I, left antennal peduncle, ventral. Scales equal 1.0 mm.

Ocular peduncles moderately large, with few short striae on dorsal surface; dorsal extension onto cornea broadly subtriangular with rounded apex, margin without setae.

Basal segment of antennular peduncles (Fig. 1H) transversely rugose on anterior lateral region of ventral surface, with short plumose setae on proximal lateral margin; anterior margin tuberculate, with acutely pointed tooth at mesial and lateral corners; margin between teeth with broad and narrow projections.

Antennal peduncles (Fig. 1I) with first segment not strongly produced forward in lateral view, provided with bluntly pointed, narrow projection at anterodistal end. Second segment provided with low, subtriangular anterior crest; dorsal and ventral surfaces slightly rugose. Third segment rather weakly elongated; anterior margin weakly produced in submedian region, tuberculate; dorsal and ventral surfaces rugose. Fourth segment small, dorsal and ventral surfaces slightly rugose.

Third maxillipeds (Fig. 2A) with coxa bearing narrow, roundly pointed distoflexor projection; distomedian projection incompletely articulated, with shallow suture. Basis articulated from ischium, subtriangular with rounded edges. Ischium broad, ovate, transversely rugose on ventral surface, with longitudinal ridge along extensor margin; distoextensor projection tapering. Merus rugose on ventral surface, with laminate, ovate lobe on ventroflexor margin. Carpus moderately rugose on ventral surface, with subtriangular projection near median region of flexor margin and with longitudinal row of short rugae along extensor margin on ventral surface. Propodus relatively slender, rugose and tuberculate along extensor margin. Dactyl small, subtriangular; ventral surface smooth. Exopod laminate, slender, with short setae marginally; proximal region inflated; distal region narrow, with flagellum.

Chelipeds (Fig. 2B–F) subequal. Ischium slightly crenulated but unarmed on ventroflexor margin, dorsal and ventral surfaces

slightly rugose. Merus with dorsal surface transversely rugose, provided with distinct, transverse ridge submedially; dorsoflexor margin with small, ovate lobe crenulated but unarmed marginally; dorsodistal and dorsolateral margins without spines; ventral surface rugose, distoflexor margin unarmed. Carpus 2.1–2.2 times as long as broad; dorsal surface moderately convex along longitudinal median line, with numerous transverse rugae, those on proximal region tending to be much larger than other parts, those on part along flexor margin smaller, rounded; very or moderately shallow, longitudinal sulcus present along dorsoextensor margin; dorsoflexor margin transverse, slightly crenulated, without teeth and lobes; dorsoextensor margin unarmed entirely, slightly elevated, distal end not produced; distal margin with broad, rounded lobe on flexor part and small or moderately large, rounded projection near extensor end; ventral surface transversely rugose, flexor and extensor margins crenulated. Chela rather narrow, flattened (in holotype, larger chela slightly inflated), elongate, 2.0–2.3 times as long as carpus, 2.8–3.2 times as long as high, lying on extensor side; dorsal surface covered with short, transverse and oblique rugae, those on fingers replaced by small rounded granules; extensor margin thin, unarmed, slightly crenulated by marginal rugae, very weakly concave on distal third; ventral surface with numerous short, transverse and oblique rugae, those on fingers being smaller; fingers crossed distally; dactyl opening at slightly oblique angle. Palm with dorsal surface provided with weakly or moderately developed, median longitudinal ridge extending from proximal end of palm to base of dactyl; dorsoflexor margin with longitudinal rugose ridge. Fixed finger with rounded ridge along cutting margin; dorsoflexor proximal part with broad, weakly developed, subrectangular or rounded projection extending onto dactyl; distal claw slightly or moderately curved; cutting edge minutely tuberculate. Dactyl 0.3–0.4 times as long as chela, subequal in length

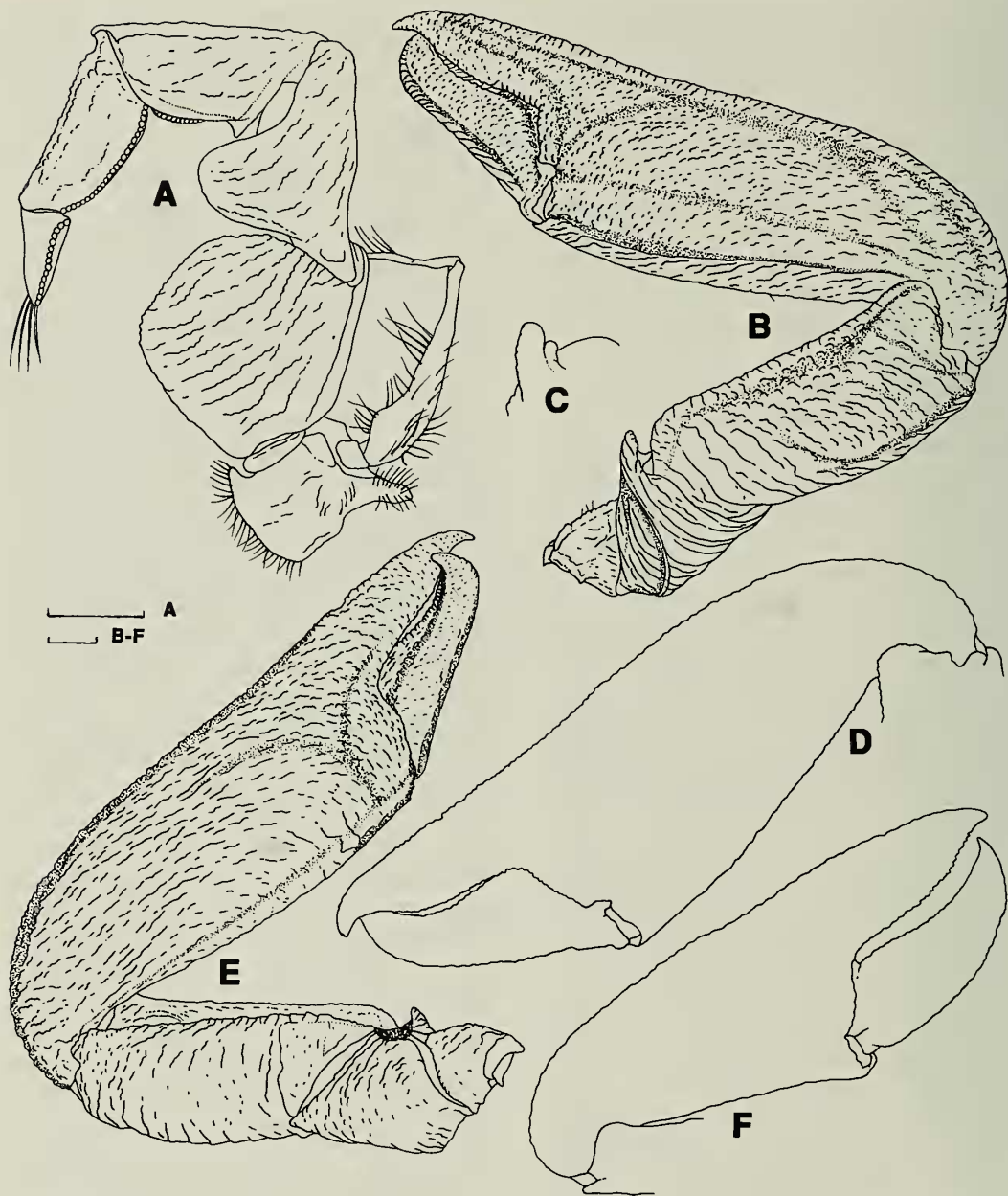


Fig. 2. *Neopetrolisthes spinatus*, new species. A–E, holotype, male (NSMT-Cr 13062, CL 8.6 mm); F, paratype, female (NSMT-Cr 13063, CL 10.6 mm). A, left third maxilliped, ventral; B, right cheliped, dorsal; C, same, merus, distoflexor corner, dorsoflexor; D, same, chela, dorsoextensor; E, same, ventral; F, left chela, dorsoextensor. Scales equal 1.0 mm.

to fixed finger, with strongly curved distal claw; dorsal surface provided with rugose longitudinal ridge along flexor margin; cutting margin minutely tuberculate. Rugae on

dorsal surface of merus to dactyl with few minute setae arising from distal sides.

Ambulatory legs (Fig. 3A–D) rather short, with few short setae except for sev-

eral tufts of setae on dactyls. Merus elongatedly subrectangular to ovate in lateral view, with length decreasing from first to third legs; extensor margin unarmed, slightly swollen; lateral surface with numerous short, transverse rugae, indistinct and reduced in number on flexor region; distoflexor margin unarmed; mesial surface without decalcified region (narrow, weakly calcified band present along proximal margin), distoflexor margin unarmed. Carpus with short longitudinal rugae on lateral surface, series of rugae along extensor margin present on first and second legs but absent on third leg; distoextensor margin unarmed. Propodus approximately as long as carpus and 2.7 (third leg)–3.2 (first leg) times as long as high; lateral surface with very short, transverse rugae; flexor margin provided with pair of movable spines at distal end, lateral spine larger than mesial. Dactyl terminating in strongly curved claw; flexor margin with 2 movable spines, distal spine larger than proximal.

Males with pair of developed pleopods on second abdominal somite (Fig. 3E); protopod with few setae on proximal region; endopod not tapering distally (with broadly rounded apex), with numerous setae except for proximal region, those on outer margin longer and stiff; exopod small, ovate, naked. Pleopods on third to fifth abdominal somites each reduced to small, rounded, inconspicuous rudiment with small pore. Females with pairs of developed pleopods on third to fifth abdominal somites, those on fourth and fifth somites large.

Color (Fig. 4).—The carapace, abdomen, and chelipeds are usually covered with very small red spots on pale or deep, reddish brown background, except for the elevated regions of white color or having few number of spots. In the holotype, the frontal and lateral regions of the carapace have white background. Meri of ambulatory legs have very small red spots on deep reddish brown background proximally, remaining parts of merus and following segments usually white.

Habitat.—Although *Neopetrolisthes maculatus* and probably *N. alobatus* have been known to live only on *Stichodactyla* species, *N. spinatus* was collected from a different sea anemone, *Heteractis malu*. The existence of *N. spinatus* on the host was also confirmed in a photograph provided by Masuda (1999, as *N. maculatus*). This species occurred as a male/female pair (the male is smaller than the female) on the sea anemone in shallow water ranging from 5.0 to 19.7 m.

Distribution.—The type locality is Okinawa Island, Ryukyu Islands, southwestern Japan. As mentioned above, Masuda (1999) showed a photograph of this species from Bali Island, Indonesia.

Etymology.—The specific name is derived from the Latin, *spinatus* (with spines), referring to the possession of supraocular spines.

Remarks.—Miyake (1937) described *Neopetrolisthes ohshimai* for a male/female pair of unusual crabs living symbiotically with a large sea anemone. *Neopetrolisthes* is closely allied to *Petrolisthes* Stimpson, 1858, but is considered to differ from the latter in several morphological characters. The features of *Neopetrolisthes* that distinguish it from *Petrolisthes* include: the carapace is elongate and the dorsal surface is strongly convex; the rostrum is laminated and lacks a median longitudinal groove on the dorsal surface (the dorsal surface is gradually oblique towards the median longitudinal line); the eyes are small; the chelipeds are short and the palms are much flattened and broad; and the ambulatory legs are subcylindrical and have few setae and spines.

Johnson (1960) concluded that *Neopetrolisthes* was not distinct enough to warrant generic status and placed it in synonymy with *Petrolisthes* arguing that the distinguishing characters provided by Miyake (1937) do not reflect a proper generic boundary. It is true that most of the generic characters of *Neopetrolisthes* are also found in some or many species of *Petrolisthes*. In

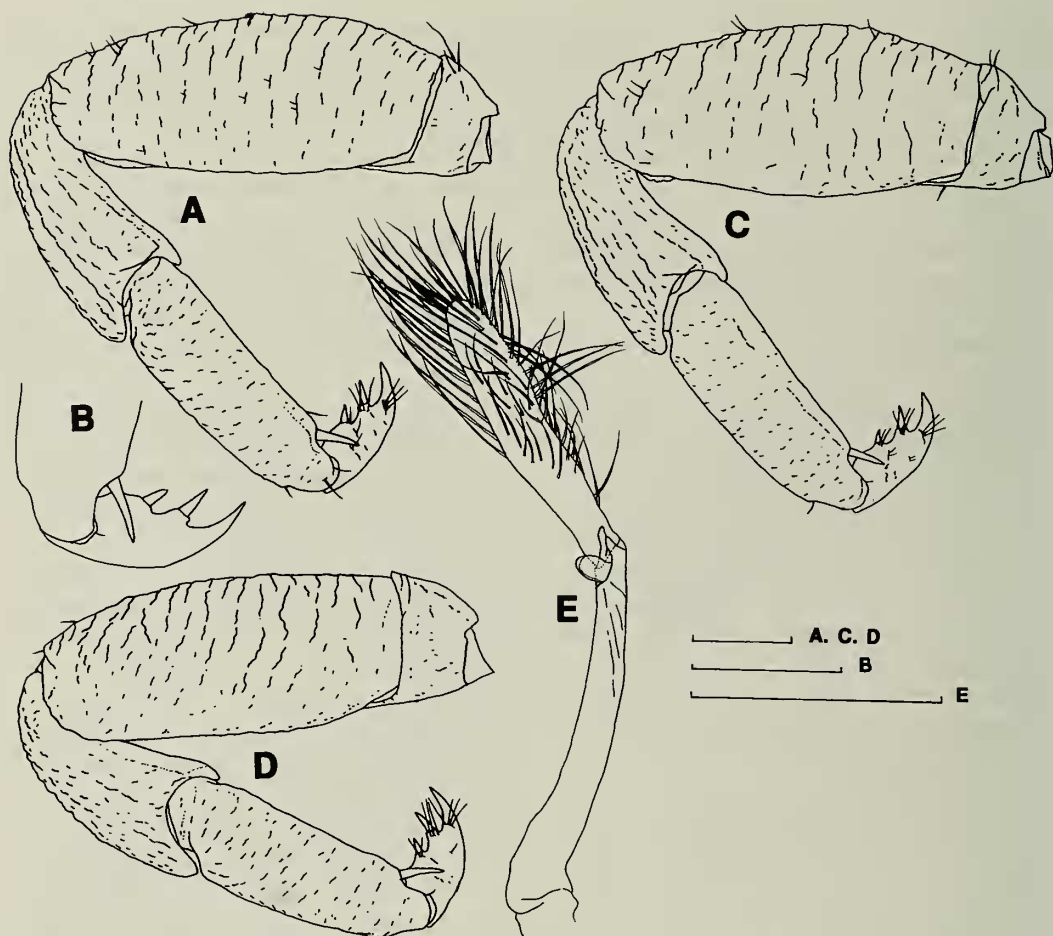


Fig. 3. *Neopetrolisthes spinatus*, new species. Holotype, male (NSMT-Cr 13062, CL 8.6 mm). All appendages dissected from left side. A, first ambulatory leg, lateral; B, same, dactyl and distal region of propodus, lateral; C, second ambulatory leg, lateral; D, third ambulatory leg, lateral; E, pleopod on second abdominal somite, internal. Scales equal 1.0 mm.

particular, it seems difficult to distinguish each of the two genera by the size and structure of the eyes, chelipeds, and ambulatory legs. The elongate carapace can be observed in *Petrolisthes virgatus* Paulson, 1875 (see Lewinsohn 1969: fig. 32a; Nakasone & Miyake 1972: fig. 1A). *Neopetrolisthes spinatus* and *N. alobatus* (see Laurie 1926: 145, pl. 9, fig. 6, as *Petrolisthes alobatus*) have a median longitudinal groove on the dorsal surface of the rostrum as in *Petrolisthes* species. The possession of only a distal pair of spines on the flexor margin of the ambulatory propodus is also

seen in *Petrolisthes haplodactylus* Haig, 1988 (see Haig 1988: fig. 4D). The third thoracic sternite incompletely divided from the fourth sternite is observed in *Neopetrolisthes spinatus* and *N. maculatus* (personal observation); this seems to be an unusual character in porcellanid crabs. However, several Indo-West Pacific species of *Petrolisthes* such as *P. asiaticus* (Leach, 1820), *P. fimbriatus* Borradaile, 1898, *P. haswelli* Miers, 1884, *P. lamarckii* (Leach, 1820), *P. moluccensis* (de Man, 1888), *P. pubescens* Stimpson, 1858, *P. scabriculus* (Dana, 1852), *P. tomentosus* (Dana, 1852),



Fig. 4. *Neopetrolisthes spinatus*, new species. Entire animal, dorsal. A, holotype, male (NSMT-Cr 13062, CL 8.6 mm); B, paratype, female (NSMT-Cr 13063, CL 10.6 mm).

P. varicolor Osawa, 1998a, and *P. virgatus*, also have this structure with a small or large, median interruption (personal observation). We believe that the strongly elevated gastric region of the carapace is a character that clearly distinguishes *Neopetrolisthes* from *Petrolisthes*. *Petrolisthes* species have a flattish or weakly convex body.

As pointed out by Osawa (1995), *Petrolisthes* is considered a heterogeneous genus, which is evident even in the zoeal characters. The generic status of *Neopetrolisthes* is supported by the larval morphology. Zoeae of this genus closely resemble those of the Indo-West Pacific species of *Petrolisthes* Group 4 (see Osawa 1995, 1997), but are distinguishable from the lat-

ter by the setation on the third endopod segment of the second maxilliped through the two zoeal stages. The species of *Petrolisthes* Group 4 have a median seta on the ventral margin, but *Neopetrolisthes maculatus* and *N. spinatus* lack it (Sankarankutty & Bwathondi 1974, as *Petrolisthes ohshimai*; personal observation). More accurate relationships of *Neopetrolisthes* and *Petrolisthes* would be clarified considering larval and adult characters.

Neopetrolisthes spinatus resembles the "small, evenly distributed spots" morph of *N. maculatus* in color and spot patterns, but is rather allied to *N. alobatus* in morphology. *Neopetrolisthes spinatus* and *N. alobatus* have the carpus of the chelipeds without distinct teeth or projections on the dorsoflexor margin and distoextensor end (see Laurie 1926: pl. 9, fig. 8; Kensley 1970: fig. 7b). However, *Neopetrolisthes spinatus* is clearly distinguished from the other two species of the genus by having an uneven dorsal surface of the carapace, i.e., well developed, elevated parts on the protogastric region, the anterior to the median branchial margins and the inner median branchial regions, and having supraocular spines. The anteriorly directed protogastric lobes are not known in any porcellanid crabs and are unique to *N. spinatus*. *Neopetrolisthes alobatus* merely has a pair of short, transverse elevations on the protogastric region and two slightly elevated parts on each the branchial regions, that of the anterior to median margin is surmounted by one or two tubercles (see Laurie 1926).

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